ELASTIC CONJUGATED YARN AND CLOTH USING SAME

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Abstract

PURPOSE:Elastic conjugated yarn useful as padding cloth, etc. having improved elastic recovery, resistance to change in color, agglutination preventing properties, comprising thermoplastic polyurethane as a core component and a polyolefin having a specific meltint point as a sheath component.
CONSTITUTION:The aimed yarn having <=30 denier of single yarn fineness, obtained by subjecting (A) a thermoplastic polyurethane (e.g., reaction product of polyol such as dihydroxy polyester, etc., having 500-6,000 molecular weight, organic diisocyanate such as tolylene diisocyanate, etc., having <=800 molecular weight, and chain extender such as hydrazine, etc.) as a core component and (B) a polyolefin (e.g., polyethylene, etc.) having a melting point 20 deg.C lower than that of the component A in a weight ratio of the component A/B of 30/70-70/30 to melt spinning. A raw material for woven and knitted goods contains preferably >=10wt% of the yarn.

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AB - Heat-bondable spandex fibers for interlining fabrics are prepd. by melt spinning together a polyurethane as the core and an olefin polymer as the sheath having difference between the melting temp. of the polyurethane and m.p. of the polyolefin .gtoreq.20.degree. to give fibers with denier per filament .ltoreq.30. Thus, a polyether polyurethane (I, m.p. 168.degree.) and polyethylene (m.p. 118.degree.) were spun together at 200.degree. and 1:1 ratio to give 1920-denier/240-filament fibers with elongation 600%. This fiber had good heat-bonding properties, whereas fibers spun from I only showed poor heat-bonding properties.

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Title of Invention:	Elastic composite fiber and fabric using it
Patent Application No.:	60-29828
Patent Application Date:	February 18, 1985
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Specifications

1. Title of Invention:

Elastic composite fiber and fabric using it

2. Claims:

(1) An elastic composite fiber, characterized in that it has a thermoplastic polyurethane core component and a polyolefin sheath component with a melting point 20°C or more lower than the melting point of this core component, and the monofilament fineness of the fiber is 30 denier or less.

(2) A woven or nonwoven fabric, characterized in that it contains at least 10 wt % of an elastic composite fiber which has a thermoplastic polyurethane core component and a polyolefin sheath component with a melting point 20°C or more lower than the melting point of this core component, and the monofilament fineness of which is 30 denier or less.

(3) A woven or nonwoven fabric in accordance with Claim (2), characterized in that its structure is stabilized by heating the elastic composite fiber to melt and adhere it.

3. Detailed Explanation of Invention:

Industrial Field of Use

This invention concerns a composite fiber with great elasticity which comprises a thermoplastic polyurethane and a polyolefin, as well as a woven or non-woven fabric which are made by using this fiber. More specifically, it concerns a polyurethane elastic composite fiber which has excellent elastic restoration, color fastness, and adhesion preventing property, as well as various

fabrics which are made by using this fiber.

Prior Art and Its Problems

Polyurethane elastic yarns have primarily been produced by the wet spinning or the dry spinning method, but these methods have the drawback that they use large quantities of solvent; therefore, in recent years, the method of melt spinning using thermoplastic polyurethane has come into use.

However, polyurethane elastic yarns have the drawback that they have a rubbery hand, easily produce blocking, and are easily discolored by light, combustion gases, etc. In particular, the melt-spinning method has the problem that the wound yarn tends to show melt adhesion, since the cooling and solidifying rate of polyurethane is slow.

Means of Solving the Problems

The inventors performed careful research in order to solve the aforementioned problems with polyurethane elastic yarns made by the melt spinning method. As a result, they discovered that this objective could be accomplished by spinning a composite fiber which has a thermoplastic polyurethane core component and a polyolefin sheath component with a melting point 20°C or more lower than the melting point of this core component, and the monofilament fineness of which is 30 denier or less.

The polyurethanes used in this invention may be polyurethanes in the broad sense, which have urethane and urea bonds in their molecules; either linear or cross-linked polyurethanes which may be used, as long as they are thermoplastic polyurethanes which can be melt-spun. For example, they may be selected from polyols with molecular weights of 500–6000, such as dihydroxypolyethers, dihydroxypolyesters, etc.; organic diisocyanates with molecular weights of 800 or less, such as p,p-diphenylmethane diisocyanate, tolylene diisocyanate, tetramethylene diisocyanate, hexamethylene diisocyanate, xylylene diisocyanate, etc.; and polyurethanes obtained by reaction with chain extending agents, such as hydrazines, diamines, glycols, etc.

The polyolefins used in this invention can be selected not only from polymers or copolymers of α-olefins, such as ethylene, propylene, butene-1,4-methylpentene- 1, etc., but also from copolymers with α-olefins as their principal ingredients and mixtures with other kinds of polymers which have these (co)polymers as their principal ingredients, e.g.., polyethylene, polypropylene, ethylene/propylene copolymers, ethylene/propylene/butene-1 copolymers, ethylene/vinyl acetate copolymers, mixtures of polyethylene and ethylene/vinyl acetate copolymers, etc. However, it is necessary to select ones which have melting points which are 20°C or more lower than the melting points of the thermoplastic polyurethanes used for the core component. By using polyolefins with lower melting points than the core components for the polyolefins of the sheath component, the elastic composite fiber of this invention can be given the characteristics of a thermoadhesive composite fiber.

The composite fiber is melt-spun by using a conventional, publicly known composite spinneret, using the thermoplastic polyurethane on the core side and the polyolefin on the sheath side. The composition ratio (by weight) can be selected from the range of core/sheath=30/70–70/30; the composite shape may be a concentric circular core/sheath shape, an eccentric core/sheath shape, or a multi-core (island/sea type) core/sheath shape. If the composition percentage of the core component is less than 30 wt %, the elasticity of the composite fiber will be insufficient, and if the percentage of the sheath component is less than 30 wt %, the discoloration-preventing effect of the composite fiber will tend to be insufficient and the blocking-preventing effect will also tend to be insufficient, due to breaking or peeling of the sheath component.

This elastic composite fiber can be used as the material for woven or nonwoven fabrics in the form of a long or a short fiber by stretching, crimping,

or cutting it, etc., as desired. In this case, however, it is desirable for the monofilament fineness to be 30 denier or less. If it exceeds 30 denier, the stretchability of the fiber will be small and it will have a high rigidity; therefore, this is undesirable.

The aforementioned elastic composite fiber alone can be used as the material for woven or non-woven fabrics, but it can also be used by mixing it with other fibers. Methods of using these mixtures may be, in the short-fiber form, the method of mixing it with other kinds of fibers and making a non-woven fabric, or the method of spinning them together and making a woven fabric. In the long-fiber form, one can use the methods of pulling and aligning them with other kinds of fiber and using them as a twined yarn, or using it as a covering yarn in weaving a woven fabric, with the elastic composite yarn as the core yarn. Furthermore, one can also use the method of mixed-weaving a yarn composed of the elastic composite fiber and a yarn composed of the other fiber. When another kind of fiber is mixed [with the fiber of this invention] in this manner, it is necessary for the content of the elastic composite fiber of this invention to be 10 wt % or more in order to impart the properties of flexibility and elasticity to the woven or non-woven fabric.

By performing a heat treatment on a woven or non-woven fabric containing 10 wt % or more of an elastic composite fiber of this invention, at a temperature below the melting point of the core component of the composite fiber and above the meting point of the sheath component, melting and adhesion of the sheath component is caused. In this way, novel properties are imparted, such as reducing piling, preventing mismatched stiches, increasing the strength of the fabric, changing the hand of the fabric to a harder one, etc. Furthermore, since binders are not needed in the non-woven fabrics, they can be made bulky

fabrics, or in the woven fabrics, one can obtain effects such as being able to control the air permeability by plugging up openings by melting and adhering the sheath component of the composite fiber. Methods of performing this heat treatment are selected as is suitable for the purposes of the final product, including hot-air, infrared, hot-pressing, hot-rolling, etc., methods.

Working Examples

This invention will be explained in more detail by giving working and comparison examples. The methods of measuring the property values used in the examples are as follows.

Fabric adhesiveness: A Teflon sheet 2 cm wide and 15 cm long was inserted between 2 fabric test pieces, leaving 5 cm of the fabrics in contact with each other at one end. The whole assembly was sandwiched between 2 Teflon sheets and this was pressed for 3 minutes at and 10 kg/cm^2 in a hot press to melt and adhere the test piece together. Both ends of the part of this test piece which was not adhered were held in the tester's hands and pulled to perform a 180° peeling test. The test pieces which could be peeled apart easily were evaluated as "1," those which gradually peeled apart when pulled strongly as "2," and those which did not peel even when pulled strongly as "3."

Strength and ductility of yarn: Using a tensile tester, the breaking point of the yarn was measured under the conditions of a test length of 5 cm and a pulling rate of 25 cm/min.

Elongation elastic modulus of yarn: Measured according to Method 7 - 10-A of JIS L 1015, with a distance of 10 cm between the clams and a pulling speed of 5 cm/min.

Light discoloration property: Using a fadometer, a sample fabric 20 mm x 64 mm in size, exposed to a carbon arc at 63°C for 20 hours, and a sample which

was not exposed were compared. The results were indicated by using the fading gray scale of JIS L 0804, from grade 1 (bad) to grade 5 (good).

Gas discoloration ability: Kerosene was burned in a commercial kerosene stove at a rate of 2.3 l/day. The sample pieces (fabrics) were placed directly above the stove at a position at which the temperature of the combustion gas was 85°C, and the fabrics were compared with the fading gray scale of JIS L 0804 and graded as grades 1–5 after 3 days of exposure.

Melting point: The exothermal peak values, measured with a differential scanning calorimeter (DSC) with a temperature rise rate of 20°C/min, were used.

Fabric strength: Using a tensile tester, a tensile breaking strength test was performed on test pieces 5 cm wide and 15 cm long, with a distance between clamps of 10 cm and a pulling rate of 10 cm/min. The mean values of 5 measurements are shown in the results.

Working Examples 1–6, Comparison Examples 1–3

Using a core/sheath-type composite spinneret with a pore diameter of 1.0 mm and a pore number of 240, the various thermoplastic polyurethanes and polyolefins shown in Table 1 were spun, with a composition ratio (core/sheath)=1/1, a total extrusion quantity of 120 g/min, and a winding rate of 563 m/min. As a result, a core/sheath-type composite fiber bundle with a total fineness of 1920d/240f (monofilament fineness 8 d/f). This fiber bundle was made into a twisted yarn with a twist number of 40/m, and a flat-weave fabric with a density of 11 threads/25 mm for both the warp and the weft was obtained.

The combinations of raw materials, spinning temperatures, yarn properties,

and fabric properties are shown in Table 1. In this table, the fabric adhesiveness (1) is the adhesiveness between samples of the fabric obtained in each example, and the adhesiveness (2) is the adhesiveness between the fabric obtained in each example and a cotton cloth (warp: No. 30, 90 threads/25 mm; weft: No. 40, 60 threads/25 mm). The symbols used for the raw materials are:

pu-1: Polyester polyurethane (melting point 175°C)

pu-2: Polycaprolactone polyurethane (melting point 196°C)

pu-3: Polyether polyurethane (melting point 168°C)

po-1: Mixture of 95 wt % high-density polyethylene (melting point 118°C) and 5 wt % ethylene/vinyl acetate copolymer (melting point 96°C)

po-2: Ethylene/propylene/butene-1 copolymer (melting point 122°C)

po-3: Mixture of 95 wt % po-2 and 5 wt % ethylene/vinyl acetate copolymer (melting point 96°C)

po-4: High-density polyethylene (melting point 118°C)

Table 1

	Composite components		Spinning temperature		Yarn properties			Fabric properties			
								Discoloration		Adhesiveness	
	Core	Sheath	Core °C	Sheath °C	Strength g/d	Elongation %	Elongation elasticity %	Light	Gas	(1)	(2)
Working Example 1	pu-1	po-1	220	220	0.94	490	84	4	4	3	3
Working Example 2	pu-2	po-1	210	200	0.92	520	81	4	4	3	3
Working Example 3	pu-3	po-1	200	200	0.91	600	86	3–4	4	3	3
Working Example 4	pu-1	po-2	220	230	0.95	480	82	4	4	3	3
Working Example 5	pu-1	po-3	220	230	0.90	610	81	4	4	3	3
Working Example 6	pu-1	po-4	220	200	0.95	450	85	3–4	4	3	3
Comparison Example 1	pu-1	pu-1	220	220	0.84	430	94	2	2–3	1	1
Comparison Example 2	pu-2	pu-2	210	210	0.88	460	93	1	2	1	1
Comparison Example 3	pu-3	pu-3	200	200	0.75	580	95	1	2	1	1

As can be seen from Table 1, the elastic composite fiber of this invention is almost equivalent, in strength, ductility, and elongation elastic modulus, to a fiber composed of a thermoplastic polyurethane only, but has superior fading resistance and adhesiveness. Furthermore, the fibers of the comparison examples sometimes broke during spinning, due to abrasion resistance at the points of contact with the yarn path guides, but this kind of trouble was not seen with the fibers of this invention.

Working Examples 7–10 and Comparison Examples 4–7:

The fibers obtained in Working Example 1 and Comparison Example 1 were crimped with a crimper (12 crimps/25 mm) and then cut to a fiber length of 65 mm to make staples. Each of these staples was mixed with rayon staple with a monofilament fineness of 2.5 d/f and a fiber length of 51 mm, in various proportions, and these mixtures were passed through a carding machine to make a 30 g/m^2 web, after which this web was sandwiched between Teflon sheets and passed through 150°C Yankee Dryer 2 times successively to make a non-woven fabric.

The fiber mixture ratios and properties of the non-woven fabrics are shown in Table 2. Furthermore, a 200°C Yankee Dryer was used in Comparison Example 7.

Table 2

Table 2

	Mixture ratios			Nonwoven fabric properties		
	Elastic yarn		Rayon	Strength	Discoloration	
	(Kind)	wt %	wt %	g/5cm	Light	Gas
Working Example 7	(W. E. 1)	100	0	4300	4	4
Working Example 8	(W. E. 1)	60	40	3800	4	4
Working Example 9	(W. E. 1)	25	75	3100	4	4-5
Working Example 10	(W. E. 1)	10	90	1800	4-5	4-5
Comparison Example 4	(W. E. 1)	3	97	950	4-5	4-5
Comparison Example 5	(C. E. 1)	60	40	160	2	2-3
Comparison Example 6	(C. E. 1)	20	80	160	3	3
Comparison Example 7	(C. E. 1)	60	40	920	2	2-3

W. E. = "Working Example"
C. E. - "Comparison Example"

As can be seen from Table 2, the non-woven fabrics of Working Examples 7–10, containing 10 wt % or more of the elastic composite fibers of this invention, had

high strengths and excellent discoloration resistances, whereas the non-woven fabric with a small elastic composite fiber content (Comparison Example 4) had a low strength, and the non-woven fabrics composed of mixed polyurethane elastic yarns and rayon (Comparison Examples 8, 9, and 10) had low strengths and were easily discolored. Furthermore, the fabric treated at a high temperature (Comparison Example 7) had a large heat shrinkage rate and a hand with many surface hills and valleys; its appearance was inferior. Furthermore, the non-woven fabrics of Working Examples 7–10 showed suitable elasticities when pulled by hand, and were suitable for adhesive tape base fabrics, covering materials for padding in clothing, clothing padding materials, etc.

Working Example 11

A flat weave was obtained by using a twisted yarn composed of an elastic composite fiber with a total fineness of 1920d/240f, obtained in Working Example 1, as the warp and No. 20 cotton yarn as the weft; its density was 12 threads/25 mm warp and 60 threads/25 mm weft. This weave had great elasticity, and was suitable for applications such as belts, supporters, base fabrics for poultices, etc.

Next, this weave was heat-treated for 15 minutes in a 145°C hot-air dryer; the elastic composite fibers melted and adhered to each other, and the warp and weft threads melted and adhered to each other at their intersections. After this heat treatment, the weave had a harder hand than before the treatment, and its elasticity was smaller, but it had the characteristics of reduced piling and the prevention of mismatched stiches. It was suitable for adhesive tape base fabrics, wrapping materials, padding, etc.

The discoloration properties of both of these 2 weaves were good: grade 4

for light fading and 4–5 for gas fading.

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